UNITED STATES MARINE CORPS

LESSON PLAN

PRESSURE GRADIENT

INTRODUCTION:

1. Gain Attention. Have you ever wondered why the winds were so intense around the circulation of a tropical cyclone? Have you ever noticed all the black lines surrounding the eye of a hurricane and wondered what they were and what they meant?

2. Overview. The purpose of this class is to introduce the concept of a pressure gradient, it's characteristics and the relationship it holds with the winds.

3. Introduce Learning Objectives.

a. Terminal Learning Objective. With the aid of references and given a constant pressure or constant height chart, explain how the designated pressure gradient is affecting a given region.

b. Enabling Learning Objective(s). Without the aid of references, but in accordance with this period of instruction:

1. Define "pressure gradient".

2. State the differences between strong/tight gradients and weak/loose gradients.

3. Describe the relationship between pressure gradient and the wind speed.

4. Method/Media. This period of instruction will be taught using the lecture and demonstration method, with the aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".

5. Evaluation. The student shall be evaluated by physically determining the location of strong pressure gradients, and stating how the pressure gradient affects the weather for a given region.

TRANSITION. Pressure is one of the fundamental atmospheric elements that are vital to forecasting weather. By understanding atmospheric pressure fundamentals, one can gain the knowledge required to successfully forecast for a given region. A pressure gradient is one of the basic concepts in pressure analyzation.

BODY:

1. DEFINING PRESSURE GRADIENT.

a. Weather stations record atmospheric pressure with a barometer in units called millibars, where 1 bar = 1,000 millibars = 14.7 pounds per square inch. Once pressure is measured, readings can then be collected over a given region and plotted on a surface

chart. It is then possible to draw isolines of equal pressure called *isobars*.

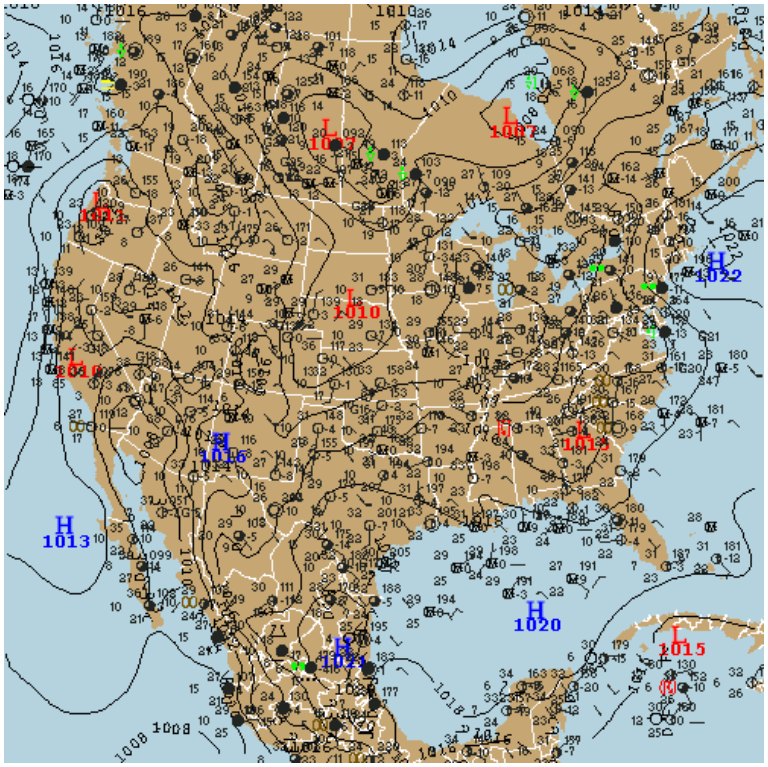

Figure 1 – Continental U.S. surface chart.

b. By evaluating the pattern of isobars on the surface chart, one can take into account the horizontal distribution of pressure over the region. On a surface chart, circular or oval areas are characterized as being either "high pressure" or "low pressure". These highs and lows represent relative conditions – pressure that is either higher or lower than the surrounding areas. It is important to keep the relative nature of pressure in mind. For example, a pressure reading of 1,005 millibars could either be "high" or "low" depending on the pressure of the adjacent areas.

c. Highs and lows may represent pressure extremes in any region, but in less extreme areas can be recognized on a weather map by the orientation of the isobars. A *ridge* (an elongated area of high pressure with maximum anti-cyclonic turning) of high pressure may separate two isobars of lower pressure, and a *trough* (an elongated area of low pressure with maximum cyclonic turning) of low pressure may separate 2 isobars of high pressure.

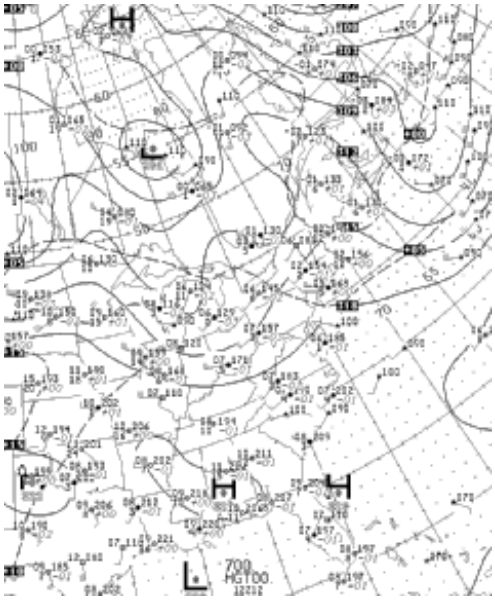

Figure 2 – Series of upper level troughs and ridges.

d. A pressure gradient represents the horizontal rate of pressure change over a given distance. The gradient can be thought of as representing the "steepness" of, or lack thereof, the pressure slope, a characteristic that has a direct reflection on the speed of the wind. Pressure gradient is directly proportional to the change in pressure and can be expressed as PG=ΔP/ Δn, where "PG" is the pressure gradient, ΔP is the change in pressure, and Δn is the given distance.

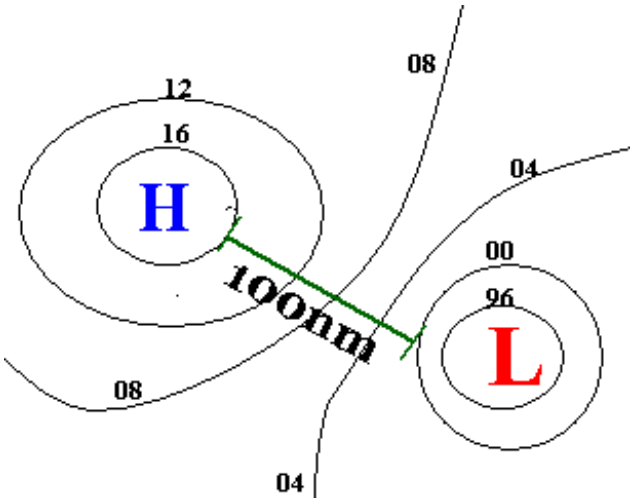

Figure 3 – Pressure gradient.

TRANSITION. By determining areas of lower and higher pressure and analyzing the orientation of the isobars, one may notice that there are times when the spacing between the isobars is different. This leads us to the next topic of "Gradient Terminology" which may be applied for any given isopleth.

2. GRADIENT TERMINOLOGY.

a. If the spacing between the isopleths is small, or many isopleths are spaced close together within a given distance, then the gradient is deemed *tight* or *strong*.

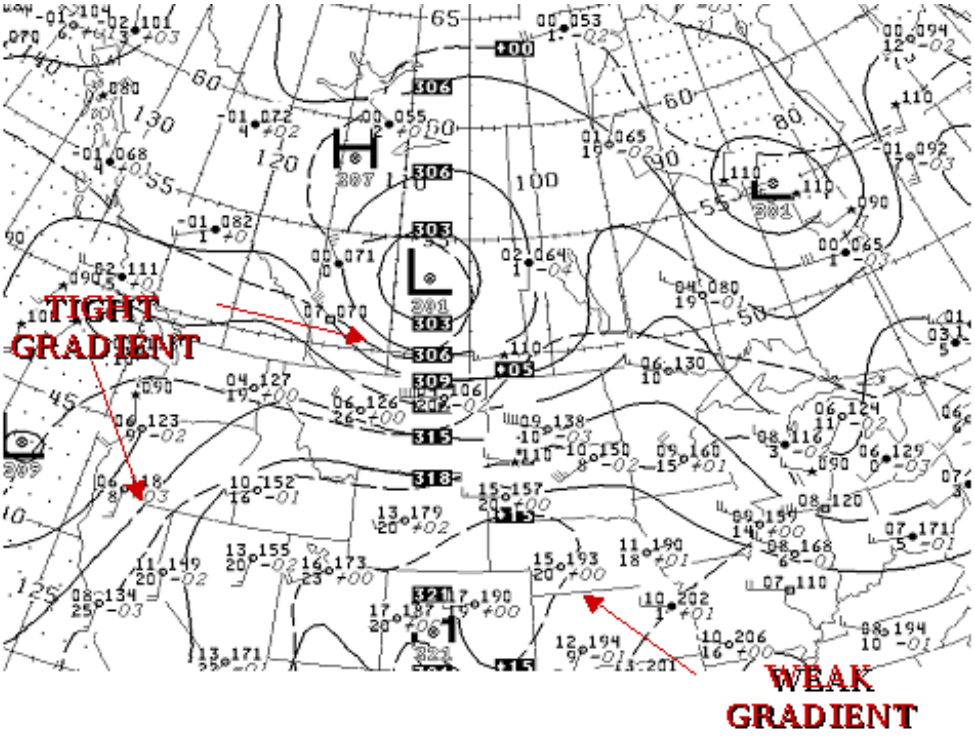

Figure 4 –Examples of gradient terminology.

b. If the spacing between the isopleths is large, or a few isopleths are spaced far apart within a given distance, then the gradient is deemed *loose* or *weak*.

TRANSITION. By determining the pressure gradient, one may determine wind speed, since changes in pressure act to initiate the winds. By using the terminology that was just discussed, one may relate the strength of the pressure gradient to the wind speed.

3. EFFECTS OF PRESSURE GRADIENT ON WINDS.

a. The pressure, or height, gradient is responsible for initiating the winds. The wind speed will be directly proportional to the pressure gradient. If there is a strong pressure gradient, the winds will increase in speed as the pressure changes more rapidly over a given distance. If there is a weak pressure gradient, the wind speed will tend to decrease with a lack of pressure change over a given distance.

b. The wind speed is directly proportional to the isobaric, or height, spacing. Meaning if the isobars are spaced closely together, then the wind speed will increase. If the isobars are

widely spaced, then the wind speed will tend to be less, if anything at all.

TRANSITION: By understanding the relationship between the pressure gradient and wind speed, it opens the door for further discussion on the winds (surface and aloft) and the combined atmospheric forces that act upon them.

OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time are there any questions pertaining to any of the material that has just been presented?

2. Questions to the Class.

a. QUESTION. If there is a strong pressure gradient dominating the local area, would the wind speed tend to be higher or lower?

b. ANSWER. Higher – Pressure gradient is directly proportional to the wind speed.

c. QUESTION. What is the definition of a pressure gradient?

d. ANSWER. A pressure gradient is the horizontal rate of pressure change over a given distance.

SUMMARY: During the period of instruction, the concepts of depicting pressure on a weather map were reviewed and the concept of pressure gradient was defined. After defining what a pressure gradient was, we learned how to describe the pressure gradient by introducing gradient terminology. Utilizing the gradient terminology, we then discussed how the strength of the pressure gradient affects the wind speed.

REFERENCE:

The Atmosphere, An Introduction to Meteorology. Frederick K. Lutgens and Edward J. Tarbuck.

Physical Geography, A landscape Appreciation. Tom L. McKnight and Darrel Hess.